

# Simulation Technology for Counter-terrorism Applications



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# Outline

***Brief History of Visual Simulation***

***Applications of Simulation in Counter-Terrorism***

***Basic Components of a Simulation***

- Displays/Interaction Devices
- Static and Dynamic Environment Database Technology

***Simulation-assisted Analysis for Counter-Terrorism***

***Conclusions***

# Quick History of Visual Systems

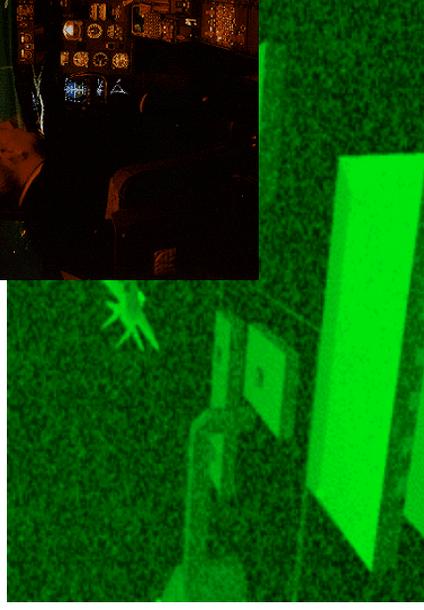
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## *Technology*

- Camera based model boards
- Stroke/Calligraphic rendering
- Raster-based Polygonal system
- Atmospherics
- Special Effects
- Texture mapping
- Geospecific Imagery

## *Applications*

- Military Flight Simulation
- Commercial Flight Simulation
- Helicopter and Ground Vehicle
- Networked synthetic battles and analyses



# Applications of Simulation in Counter-Terrorism

## **Concept: *Simulated Command Center***

### ***Security review of existing facilities***

- Realistic model of urban environment for analysis
- Tactical Planning - ingress, escape routes

## ***What-if Scenario Training***

- Rehearse response to pre-scripted disaster scenarios
- Practice command & control decision-making
- Practice information flow and review during an incident
- Test effectiveness of Command & Control organization



(NASA/SGI Virtual Air Traffic Control Tower)

# Display/Interaction Devices

*Reality Center Powerwall*

*DART / Cave Display*

*Command Center Consoles*

*VR displays and positioning devices*

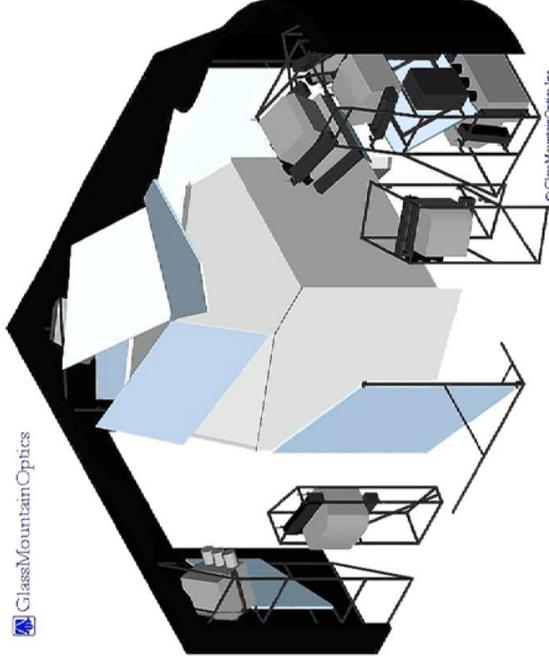
- *Useful for individual trainers attached to simulation*

*High Innovation in Displays*

- Retinal Displays
- Tiled, high-res LCDs at 4k x 4k
- T1 micro-mirror DLP



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# Database Development Process

## *Traditional*

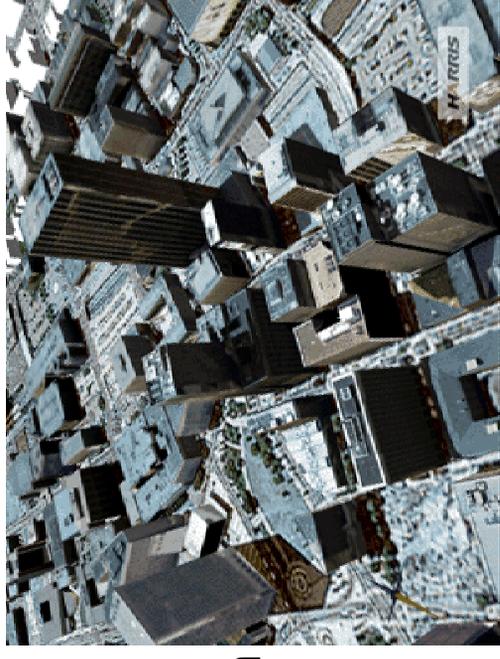
- Acquire and prepare source data
- Create Polygonal Terrain Skin
- Plant and edit 2D Cultural Features
- Add 3D models for buildings, bridges, etc.



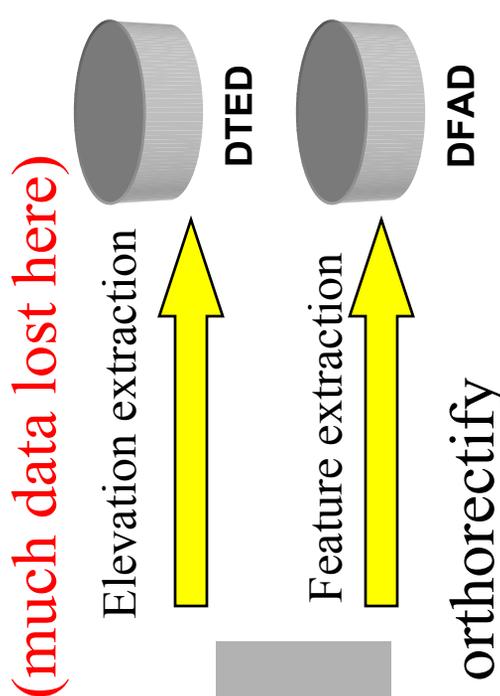
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## *State-of-the-Art*

- Use Geographic Information System (GIS) data
- Feature Extraction from Imagery
- Use Satellite and Aerial photos for realistic terrain (example to right: Atlanta by Harris RealSite)

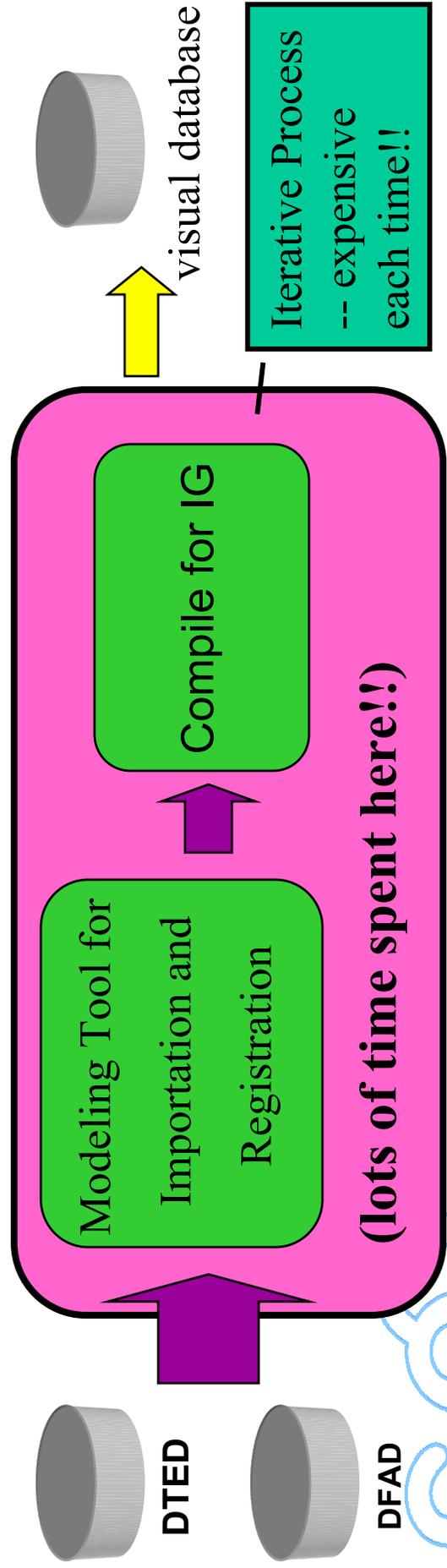


# Traditional Dataflow



(much data lost here)

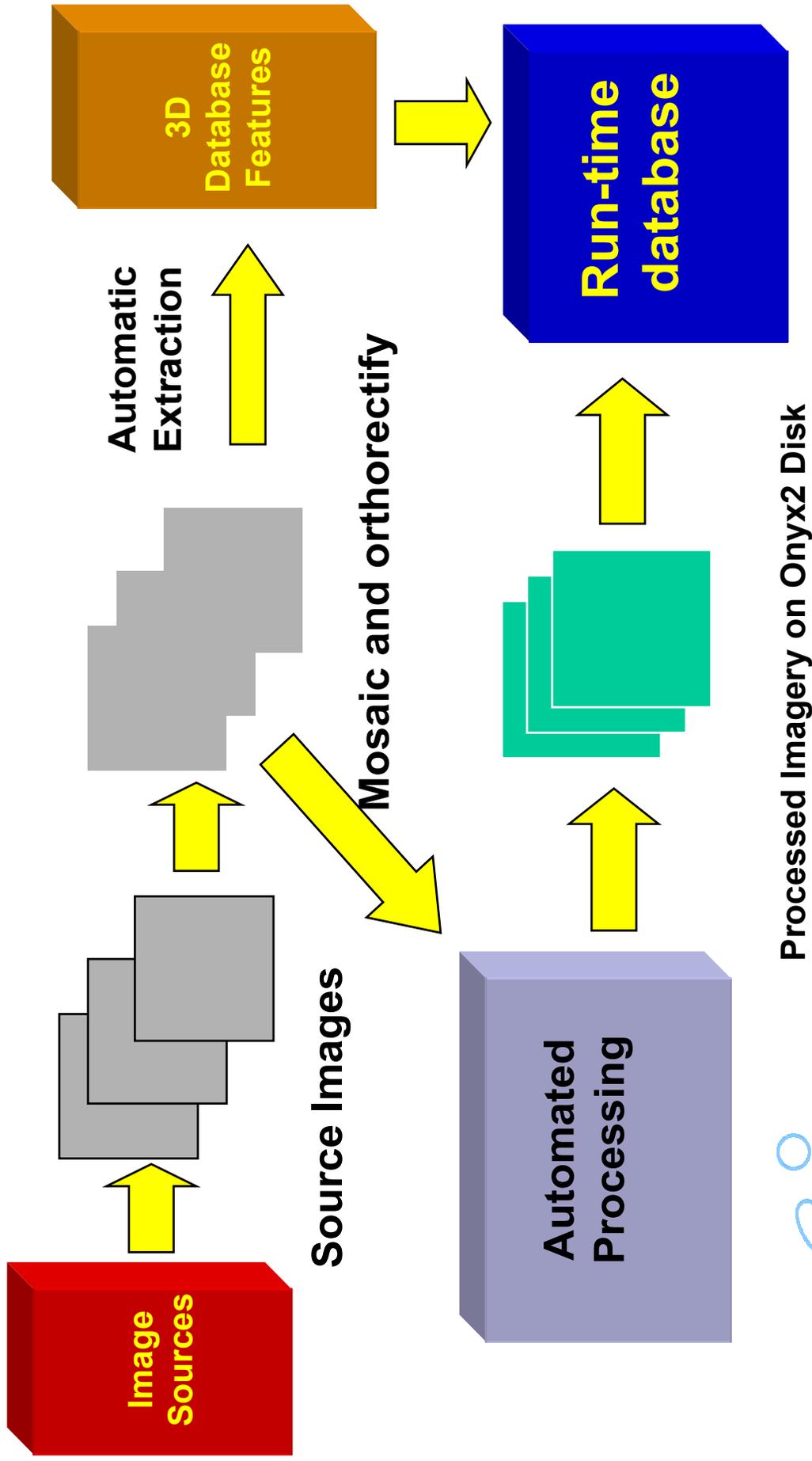
Images across time Mosaic and orthorectify



(lots of time spent here!!)

Iterative Process  
-- expensive  
each time!!

# Image-based Database Process



# TerraSim TerraTools

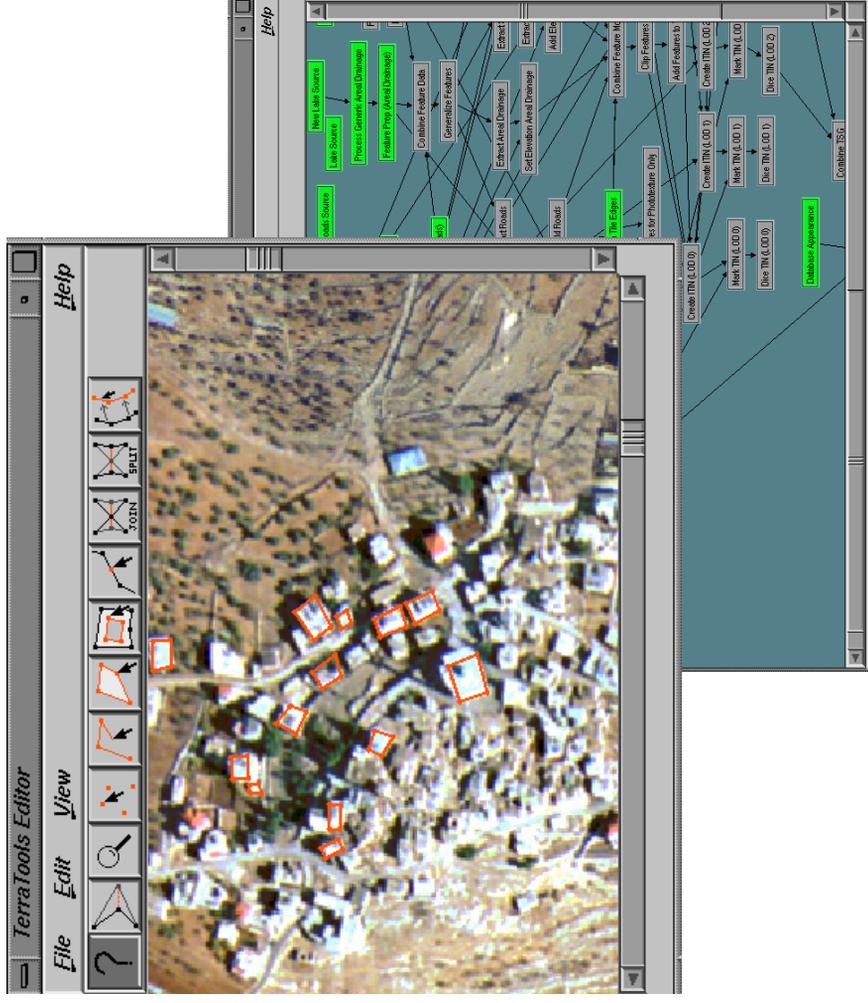
*Accepts GIS, imagery, elevation, and feature data*

*Automates the dataflow of the DBGS process*

*Script language for large databases*

*Parallel processing of project graph*

*Constrained TIN algorithms*



# TerraSim - Philly & Pittsburgh examples

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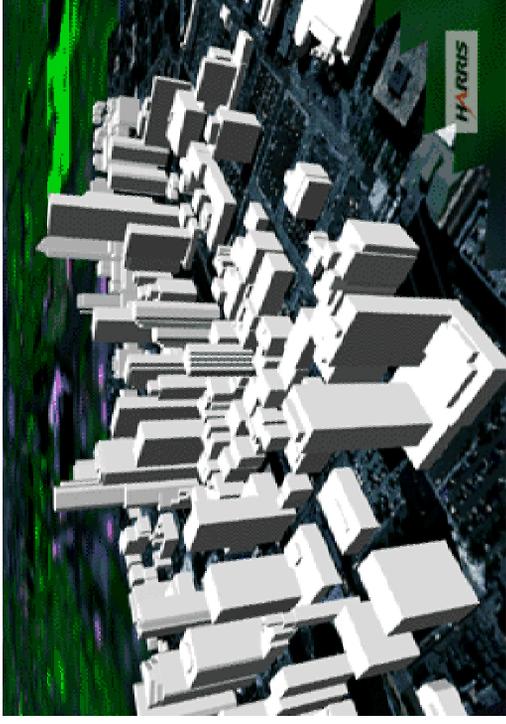


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# Harris RealSite

*Geometry is Auto-Extracted  
from Imagery*

*Building Sides textures  
generated from satellite, aerial,  
or handheld photos*



*Models can be hand enhanced  
as needed after auto-extraction*

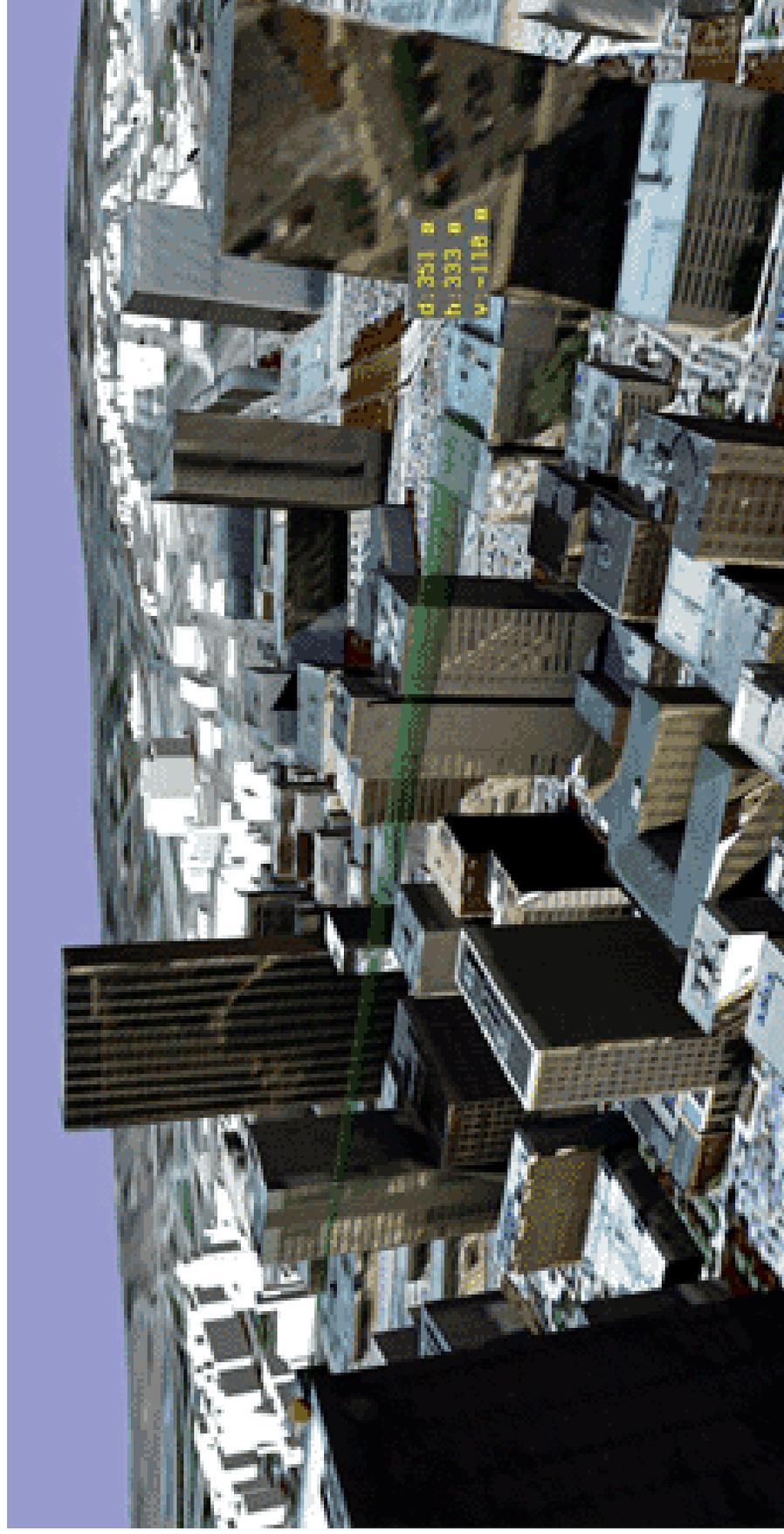


*Interactive environment  
InReality provides mensuration  
tests for information discovery  
from datasets*

# Harris InReality

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***Mensuration - determines distance and line of sight from any point on the database***



# The Role of the Database

*The Database is used for both rendering and analysis*

*The environment database needs to support all calculations, analyses, and queries necessary for any simulated behavior*

- Line of sight tests; terrain following
- trafficability and maximum speeds for certain vehicles ( logistics calculations and
- Smoke/HazMat cloud dispersion

*Next step for better interaction with datasets:*

**Dynamic Terrain and Dynamic Environments**



# Dynamic Environment Technology

## *Dynamic environment effects*

- Soil slumping and digging
- Water flow and Erosion
- Building Damage from munitions

## *Analytical models need to be resolution independent*

- Simulators connected together will have different purposes (individual on ground vs. reconnaissance helicopter)

## *Efficient physical models needed for run-time execution*

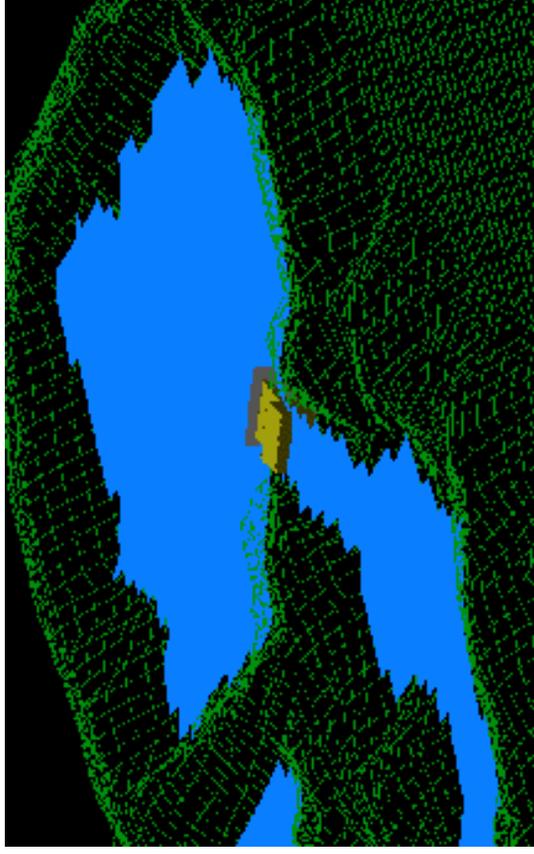
- Tradeoff between accuracy and speed



# Simulation Techniques

## *Efficient soil slumping model*

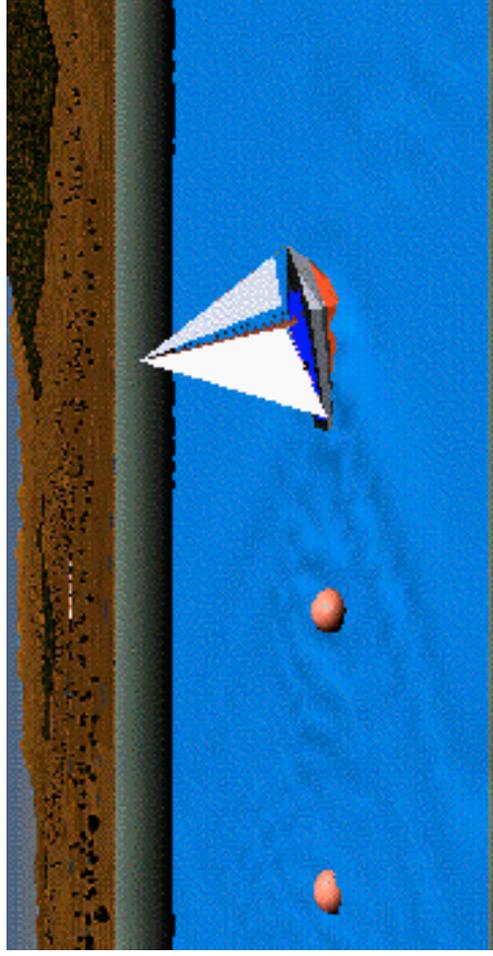
- Li, Xin, Physically-Based Modeling and Distributed Computation for Simulation of Dynamic Terrain in Virtual Environments, Ph.D. Dissertation, University of Central Florida, Orlando, May 1993.
- Li, Xin, and Moshell, J. M., “Modeling Soil: Realtime Dynamic Models of Soil Slippage and Manipulation”, SIGGRAPH’93, Anaheim, California, July 1993.



# Simulation Techniques

## *Efficient water flow model*

- Chen, Jim, “Physically-Based Modeling and Real-Time Simulation of Fluids”, Ph.D. Dissertation, University of Central Florida, Orlando, May 1995.
- Chen, Jim, et al., “Towards Interactive-rate Simulation of Fluids with Moving Obstacles by Navier-Stokes Equations”, Computer Vision, Graphics and Image Processing, March 1995.



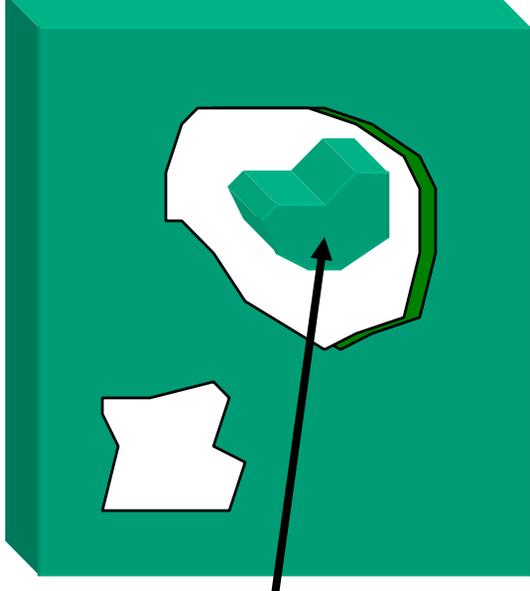
# Simulation Techniques

## *Efficient Building Damage Models*

- Ortiz, Russell, Lisle, “Towards an Implementation of Damageable Buildings”, I/ITSEC’96 conference, Orlando, FL.
- 2 1/2 dimension CSG (computational solid geometry) calculations
- Waterways experiment station physical model

## *Two Major Algorithms*

- Real-time CSG for holes
- “Is part still grounded” or should it fall?



# Simulation Techniques

## *US Army Technologies*

- USA Waterways Experiment Station
  - High-fidelity CFD models of building damage
  - Efficient, empirical models for damage according to material types
- Aberdeen Proving Ground
  - DICE (distributed computation of high-fidelity models on HPC systems)
- White Sands Missile Range
  - Smoke and plume spreading models (e.g. COMBIC)
  - EOSAEL (Electro-Optical Systems Atmospheric Effects Library)  
<http://www.eosael.com>

***Quality vs. efficiency tradeoff for physical models***  
***Software architecture for use in real-time simulation***

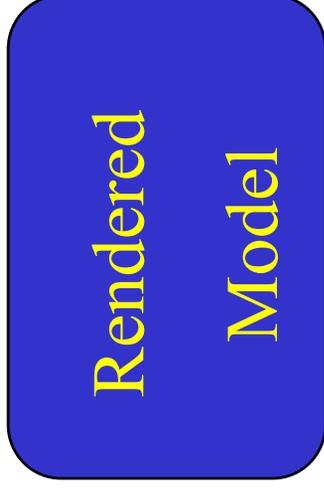
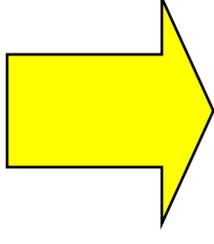
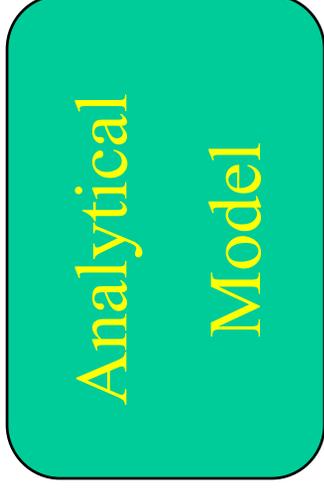


# Dual Modeling Approach

*Don't try to put analytical values on a polygonal database*

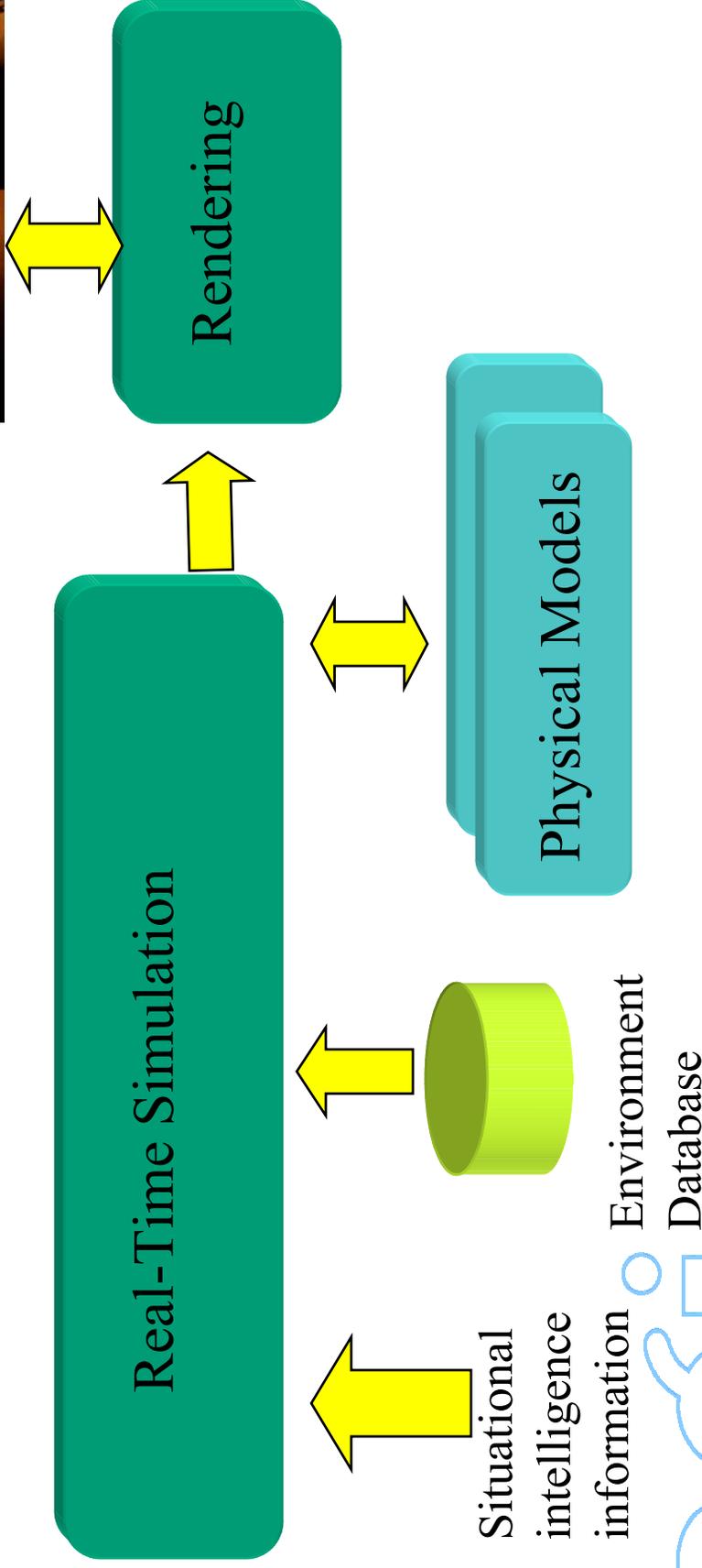
*Instead, regenerate the rendering data structures from the analytical ones as needed (when state changes appreciably enough)*

*Dead Reckoning - technique for controlled approximations*



# Command and Control Center

*Simulation receives situation information, processes events, uses physical models, and calculates behaviors and environment state updates*



# Conclusions

***Many options for processing source data into datasets for visualization and analysis in counter-terrorism applications***

***Synthetic database content and design are critical to successful simulations***

***Training and live operational modes the same command and control center is a powerful concept***

- maximize team training effectiveness
- Maximize cost and use of physical and computer resources

***Simulation is a powerful tool for counter-terrorism efforts***

